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AUTHOR Eriksen, Erik, Ed.
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ABSTRACT

Effective use of computers in instruction is contingent upon a district-level philosophy and plan. That plan may be based on either a computer literacy course model, a scope and sequence model, or an integrated model. Each of these models involves some combination of five categories of computer-related instruction: (1) teaching about computers as the subject of the instruction; (2) teaching computer science (programing language); (3) teaching productivity software (word processing, databases, and spreadsheets); (4) teaching about social issues related to computers; and (5) teaching with a computer to accomplish other instructional objectives. The first two sections of this guide describe each of the three computer use models and the five computer-related instruction categories in detail. Primary uses of computers in instruction (including the teaching of thinking skills, the teaching of data analysis, and the teaching of the writing/revising process) are outlined and described in the third section. Guidelines for software selection are included. The fourth section presents suggestions for planning inservice programs to train teachers to use computers in the classroom. A structure for a teacher curriculum in instructional computing, containing topical outlines for each of the five categories of computer-related instruction, concludes the document. (GL)

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A MODEL CURRICULUM FOR TEACHING TEACHERS TO USE COMPUTERS AS AN INSTRUCTIONAL AID

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A MODEL CURRICULUM

FOR TEACHING TEACHERS TO USE

COMPUTERS

AS AN INSTRUCTIONAL AID

Developed by:

Robert M. van Deusen, Ph.D.
Instructional Computing Consultant
Grant Wood AEA

James E. Scheib, Ph.D.
Staff Development Coordinator
Grant Wood AEA

Jean Donham
Media Coordinator
Iowa City Community Schools

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Erik Eriksen, Editor

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A MODEL CURRICULUM FOR TEACHING TEACHERS TO USE COMPUTERS AS AN INSTRUCTIONAL AID

INTRODUCTION

Effective use of computers in instruction is contingent upon a district-level philosophy and plan. That plan may be based on one of three computer use models:

- **Computer Literacy Course Model**
- **Scope and Sequence Model**
- **Integrated Model**

Each of these models involves some combination of these five categories of computer-related instruction:

- **Teaching about computers** as the subject of the instruction.
- **Teaching computer science** (programming language).
- **Teaching productivity software** (word processing, data bases, spreadsheets).
- **Teaching about social issues** relating to computer use.
- **Teaching with a computer** to accomplish other instructional objectives.

PART I

COMPUTER USE MODELS

Computer Literacy Course Model

In the Computer Literacy Course Model, the vast majority of the common learnings about computers are concentrated into a formal course or sequence of courses.

Advantages:

- The teacher is usually knowledgeable about computers.
- The course modules fit conveniently into existing scheduling.
- Hardware can be consolidated into one room.
- All students receive the same experiences at the same grade level.

Disadvantages:

- Teaching may be outside of an instructional context. There is often no application in the learning process.
- Some teachers may be discouraged from using computers in their classrooms because the "computing teacher" has priority for resources like equipment, inservice, and software.
- Literacy course teachers may not be the best teachers for teaching specific applications. For example, often a writing background is far more important than a computing background in teaching word processing.

Scope and Sequence Model

The Scope and Sequence Model identifies specific learnings to be taught at each grade level. Typical scope and sequence charts show behavioral objectives or skills by grade level and indicate the degree of mastery expected for each skill. This model often uses a four-step approach, namely: introduce, expand, review, and master.

Advantages:

- Learnings are reinforced over several years.
- More teachers become involved in teaching computer use.
- Scope and sequence can be clearly defined.

Disadvantage:

- Teaching can be outside of an instructional context. Just as with the Computer Literacy Course Model, there is often no application in the learning process.

Integrated Model

The Integrated Model requires that the computer be used appropriately to facilitate instruction in all curricular areas. Teachers are trained to integrate the computer into their instructional methods or content. In this model the computer is used as another media device to facilitate the teacher's instruction. The one-computer-per-classroom model is very useful when supported by a large screen.

Students are shown what they need to know to use the software. Little emphasis is placed on the computer itself except insofar as it is needed to accomplish the instructional goals of the other subject matter. A strong emphasis in this approach is on the use of the computer as applied to everyday tasks, such as the use of word processing, data bases, spreadsheets, and graphics software. In addition, this model lends itself to the use of the computer to teach thinking skills.

Advantages:

- Many teachers are trained in computer use.
- The computer supports instruction in other areas.
- The teaching occurs within the context of the need for it.
- Learnings are immediately reinforced in a practical application.

Disadvantages:

- There may be gaps in the students' formal understanding of computers.
- Access to computers by a large number of faculty is essential.

The scope and sequence and course models were popular when the concept of computer literacy was first being implemented by school districts and states. Recent trends and literature emphasize a movement toward the integrated approach and a literacy concept based on the use of application software rather than programming languages.

Similarly, there has been a movement away from drill and practice software toward more sophisticated software that aids in the development of concepts. District plans can be a combination of these models, but the movement toward the integrated approach can only be achieved in individual classrooms by teachers using appropriate software to facilitate instruction.

PART II

COMPUTER-RELATED INSTRUCTION CATEGORIES

Teaching About Computers

There is some fundamental content all students should learn about computers. That content can be taught to students in the context of other educational computing experiences. For instance, as students are using a program in science, social studies, or mathematics to achieve instructional objectives, they can be taught such essentials as computer vocabulary, diskette care, or operation of the hardware.

Teaching Computer Science

Teaching computer programming is appropriate only for those students who have the interest and aptitude. The formal structure and abstract conceptualization in programming make learning to program inappropriate for some students. However, for the students who have the aptitude for it, learning to program can help them develop skills in logic and analysis which can be of value in various problem-solving situations.

Teaching Productivity Software

Productivity software (e.g., data bases, authoring systems, gradebook software, materials generation, spreadsheets, and word processing) is by definition a problem-solving tool. For teachers to use productivity software for their own work and to teach students to use such software, the idea is that application of the skill and using the software is the goal, not merely mastering the use of the program itself. For example, teaching word processing to students should be related to the teaching of the writing/revising process and application of those word processing skills should be an expectation for those students. Or, teaching use of a database management package should be related to a project involving organization and analysis of information.

Teaching Social Issues

The social issues raised by computer use in society would best be taught by those people who deal with social issues — social studies teachers. A course on the impact of the automobile on the demographics, the values, and the economic system of a nation would not be taught by the drivers education teacher, nor the auto mechanics teacher. In fact, the teacher of this course would quite likely be a non-technical person with background in history, sociology, or other social studies disciplines.

Teaching with Computers

Educators must identify the appropriate curricular niche for computers in determining how best to use this technology in teaching. The computer has specific capabilities which make it an ideal teaching tool for certain classroom situations, but it is not the ideal medium for all classroom instruction. Research is inconclusive regarding the learning outcomes resulting from drill and practice in lower order thinking skills like recall. However, if the focus of the lesson were hypothesis formation and testing, deductive reasoning, analysis, sequencing, classifying or categorizing, the interactive nature of the computer does make it an ideal teaching tool. In this situation, the software helps focus understanding by providing feedback to the students which they may use to modify their thinking strategies. The controlled environment created through the software design allows emphasis to be placed on the development of the thinking skills without the distraction of other curricular content.

PART III

PRIMARY USES OF COMPUTERS IN INSTRUCTION

Teaching with computers and teaching productivity software incorporate the unique capabilities of the computer to provide instruction in three areas which are of considerable benefit compared with standard methods of delivering instruction.

These are:

- The **teaching of thinking skills** using commercial software or by using Logo (teaching with a computer).
- The **teaching of data analysis** using data bases, graphics programs or spreadsheets (teaching productivity software).
- The **teaching of the writing/revising process** using a word processor (teaching productivity software).

Before meaningful instruction with a computer can be attempted in these three areas, appropriate software must be carefully selected. In the area of thinking skills, teachers must look for that software which is designed to help them ask open-ended questions, questions with multiple answers. Software in which the instructional mode is drill and practice is not appropriate for this model. Instead, software which deals with thinking strategies, gathering data, organizing data, and formulating and testing hypotheses meet instructional goals in ways that are not addressed in other instructional media.

In choosing word processing and other productivity software, simplicity and availability of features which the students will indeed use are critical issues. Generally, district-level, committee-based decisions on software selection are likely to hold up best. First-hand evaluation of software is essential, but it is also time consuming. In each school district, a team needs to be identified to preview software using stated criteria and make recommendations for use.

TEACHING OF THINKING SKILLS

Using Commercial Software

Effective use of the computer to teach thinking skills occurs best in a teacher-controlled situation. The ideal model utilizes one computer connected to one large-screen monitor for the class and one small color monitor for the teacher; the teacher is in control of the keyboard. The teacher and students then work collaboratively to solve the problems; the students discuss, hypothesize, and organize data related to the problem. The teacher introduces students to the software, poses questions, and guides the students in the problem-solving process; then the teacher and students together analyze their process to clarify the problem-solving steps they have used. The teacher then relates these problem-solving strategies to other situations in order to increase the likelihood of transfer of the skill to other problem-solving situations. In this model, the students "use" the computer in much the same way as they "use" a 16mm projector, a chalkboard, or an overhead projector. The interactive nature of the computer gives it its unique instructional potential.

Students, in the process of solving a particular problem, will learn about sequence, hypothesis testing, organization of data, and other important areas of solving problems. The goal is to cause thinking and to analyze that thinking. In order to put students into a problem-solving environment, it is essential that an open, trusting environment be established. The teacher must not be identified as the answer-giver, evaluator, critic or praise-giver, but rather the person who facilitates by asking questions. It is the computer's role to provide the feedback that lets the student self-evaluate.

If during a lesson a teacher knows that a student's analysis of a problem is incorrect, the teacher should refrain from evaluating. Rather, the teacher should follow the student's suggestion. The computer will show the student the result of the hypothesis. At this point, the teacher asks, "What could we do to change the result? Where should the change occur in the sequence? What kind of strategies can we use to make the decisions?" The teacher models for the student appropriate self-questioning. Through identifying oneself as a collaborator, the teacher helps students overcome the fear of being "wrong." Questions like "What do you think? Why do you think that? How did you figure that out?" help students and teachers to analyze their thinking process and evaluate their logic. By using language to describe thinking, students clarify their thinking. Using language gives teachers the information they need to intercede effectively in the process of learning to think more clearly. In short, to understand thinking, students must verbalize the process.

The computer is an ideal medium for teaching thinking for several reasons. When teachers try to integrate the teaching of thinking into content areas, the struggle between teaching content and teaching process is inevitable; in most instances content wins. Given appropriate problem-solving software, the computer creates a microcosm, a manageable environment in which the focus can clearly be on the process. Unlike other media, the computer is interactive; decisions the students make have immediate results which alter the next options available; this creates a realistic problem-solving environment. Feedback comes from the computer; this takes the teacher out of the evaluative role and allows the teacher and students to work in a collaborative relationship to solve the problem; this relationship can remove the fear of taking risks, so that students can indeed try out their ideas and test their hypotheses without concern about teacher judgment.

Using Logo

In addition to the use of commercial problem-solving software to teach thinking skills, another viable use of the computer for instruction is the teaching of thinking skills using Logo. Logo is a language which teaches students concepts about thinking, computer languages, and geometry earlier than through more formal and traditional means. The processes of planning, executing the plan, receiving feedback from the computer, debugging the plan and then executing it again, are applicable to solving many types of problems. The teaching of Logo should focus not so much on the conventions of the language, but rather on strategies to solve problems; these may include "walking" out problems, talking, modeling, drawing, hypothesizing, organizing, sequencing, and classifying. One important factor to consider with regard to Logo, however, is that teaching Logo effectively requires 30 to 60 hours of teacher training time to take teachers beyond focusing on the language to focusing on the concepts behind the language. Again, the unique characteristics of the computer enhance the value of Logo as a strategy for teaching problem-solving skills.

TEACHING OF DATA ANALYSIS

Another way of using the one computer/one class model is to have the computer organize information in a more useful way so that attention to generalizations and interpretations becomes the primary focus rather than the specifics of calculation. For example, one might take data in a social studies class, organize the data with a data base, graph the data, and then make graphs available to the students. The students might spend a whole class period analyzing and interpreting the data rather than actually building the graph. Another example setting might be a math class. If the relationship among particular numbers could best be shown by using a graphing program, the class could analyze the relationship to determine the critical elements that make parabolas, hyperbolas, ellipses, circles, or lines. The questions become, "What is there about the equation that tells us what the curve is going to look like? Can we look at a curve and work backwards to see if we can make the geperalization about the equation?"

TEACHING OF WORD PROCESSING

In the teaching of writing, the computer is of particular value in teaching the editing/revising process. While a student may spend equal amounts of time entering an original draft of a piece of writing into the computer as handwriting it, the revisions of that draft are easier and faster. Also, the attitude of the student toward revision is likely to be much more positive.

The process of revision can be modeled effectively by the teacher with the computer and a large-screen monitor. Then students can move to the computer keyboard personally to enter and revise their work.

Before students can be expected to use word processing efficiently, they must be taught standard keyboarding techniques. Keyboarding research has shown that fourth graders handwritten transcription rate is about 11 words per minute. To teach students in grades three through five to type at the rate of 15 gross words per minute (GWPM) takes 26 hours (Wetzel, 1985). To teach students in grades six or seven to type at the rate of 18 GWPM takes eight hours (Stoecker, 1986). Decisions relating to the appropriate grade to begin word processing should consider these data.

PART IV

TEACHER INSERVICE

In order to teach with a computer, teachers must be trained. Teachers need to have the same experiences that they will be providing their students. In the area of thinking skills, the teachers' instructor must choose software that deals with problem solving and teach teachers using that software. The process of working through the problem solving, hypothesizing, testing, organizing, classifying, and categorizing is essential if teachers are going to teach the same way in their own classrooms. Modeling for teachers is essential. Once the model has been given and the parts of the model have been identified (e.g., questioning strategies, teaching decisions, collaborative posture, etc.), teachers must look at software appropriate for their own classroom. They must analyze how software can be infused into the curriculum and how they will not only teach the thinking skills but relate them to other situations in order to enhance transfer of learning.

During teacher education, emphasis must be placed on fitting the software into an instructional context. The issue of prerequisite skills must be addressed; what skills must the students have before they can succeed with this software. Teachers must also consider that using the computer often fits into the semi-concrete or semi-abstract stages of understanding a concept. Relating the computer experiences to paper and pencil tasks or manipulative tasks must be emphasized for teachers.

Teacher training must include guided practice. Teachers must personally try out teaching with computer software in a situation in which they will receive helpful feedback. This experience is essential before teachers are likely to feel confident to say, "This is a teaching methodology I can use to achieve my teaching objectives."

So, teacher training must include identifying appropriate software, modeling the use of the software with students, understanding the fit of the computer into the curricular context and guided practice in actually using the computer as a teaching tool.

In the area of word processing inservice, the same components of teacher inservice are needed. In addition, teachers ought to become personal users of the word processing program that they will teach; this will give them a sense of mastery and confidence in the classroom.

Encouraging teachers to use the computer as a teaching tool is asking teachers to change their behavior. To change behavior, teachers need significant amounts of time immersed in activities that will cause them to react favorably toward a new way of teaching. If people have sufficient hours of involvement in a new way of thinking and a new way of behaving, and if they have a support system that will allow them to continue to grow, there is then a chance to change behavior.

Structure for a Teacher Curriculum in Instructional Computing

A. Teaching About Computers

Information about how computers work and how to use them is needed by all users, teachers and students alike. A good understanding of why the equipment behaves the way it does goes a long way toward making a new user comfortable. The areas of knowledge at the "new user level" are equally appropriate for students and teachers and form the core of information usually offered in introductory sessions for new users.

1. New User Level

a. Starting up a system
   - Booting
   - Rebooting

b. Simple printer use
c. Computer vocabulary
d. Diskette care
e. Ethical use
f. Formatting disks
g. Transferring files
h. Keyboard
   - Keys
   - Functions

i. One-drive vs. two-drive systems
j. Diskette construction and functioning
   - Two-sided disks
   - Write-enable notch, tabs

A second level of information about how computers work is essential to the understanding and implementation of more advanced procedures on microcomputer systems, even with the use of sophisticated and user-friendly software. These areas of information should be pursued on a need-to-know basis by teachers and would be taught to students when essential for specific applications.

2. Other System Use Skills

a. Bits, bytes, diskette/memory space
b. Understanding operating systems
   - Structure and characteristics
   - Commands

c. Advanced printer use
   - Embedded printer codes
   - Graphic screen dumps

d. Telecommunications
e. Troubleshooting
   - Checking cables
   - Checking disk contents
   - Verifying disk media
   - Verifying drive speed

f. User support groups
g. Hardware care
h. Simple maintenance procedures
i. Hardware: types and uses
   - CPUs
   - Drives
   - Monitors
   - Printers
   - Special interface cards

j. Interfacing devices
   - Mouse
   - Joystick
   - Graphics pad
   - Scientific instruments

k. Legal backup of disks/programs
l. Networking: concept vs. availability

A third division of knowledge about computers encompasses the resources and issues relating to teachers only. These include professional issues and the selection of software.

3. Teacher-Related Topics

a. Types of software
   - Instructional
   - Productivity
   - Classroom management

b. Software available for review
c. Software directories
d. Software review and evaluation
   - Criteria
   - Process

e. Professional organizations
f. Educational magazines
g. Certification requirements

B. Teaching Computer Science (programming language)

The teaching of programming languages is appropriate in elective courses where the interested students have been admitted based on their aptitude for the abstract conceptualization that is inherent to programming.

1. Advanced Understanding of Operating Systems Commands

2. Addressing

a. Memory map
b. Peeks
c. Pokes
d. Screen addresses

3. Programming Utilities

a. Line editor
b. Debuggers
c. Program writing programs

4. Internal Monitor

5. BASIC

6. Logo

7. Pascal

8. Forth

9. HyperCard

C. Teaching Productivity Software

Skill in using productivity software can significantly streamline non-teaching duties for the teacher. In addition, some of these applications are appropriate for students to facilitate processes in specific curricula.

1. **Teacher Utilities**
   - a. Classroom management
     - Gradebook
       - via spreadsheet
       - gradebook program
     - Data bases
     - Mail-merge applications
   - b. Authoring systems
   - c. Testing via computer
     - Test construction programs
     - Test scoring
   - d. Materials generation
     - Graphics
     - Classroom graphics
     - Slide shows
     - Graphs
     - Word Processing
2. **Spreadsheets**
3. **Computer Aided Design/Drafting (CAD)**
4. **On-Line Database Searches**
5. **Desktop Publishing**

D. Teaching About Social Issues

The social studies curriculum is the appropriate environment for addressing social issues related to computer technology. Ideally these issues will be discussed in broad context as they relate to other social, economic, or historical issues. However, the ethics of computer use should be understood, implemented, taught, and enforced by all staff.

1. **Careers Created or Impacted by Computer Technology**
2. **Legal and Ethical Issues**
   - a. Piracy
   - b. Privacy
   - c. Destructive practices by hackers
3. **History/Trends**

E. Teaching With Computers

The following "general knowledge" concepts will need to be thoroughly understood by all teachers who have identified appropriate software for their grade and subject area, regardless of the computer use model chosen.

1. **General Knowledge**
   - a. Appropriate uses
   - b. Classroom strategies
     - Teacher directed
       - Large group presentation
       - Small group problem-solving tasks
     - Student directed
       - Small group problem-solving task
       - Individual use
   - c. Infusion of software into the curricula
   - d. Software evaluation
   - e. Software review sources
   - f. Types of programs
   - g. State curriculum
   - h. Instructional design of software

Some areas of learning are especially well supported by, or have grown out of, the instructional use of computers. Teachers who will include these skills in their curriculum will have to become thoroughly familiar with the supporting software and techniques.

2. **Special Content**
   - a. Thinking skills
     - Commercial software
     - Logo
   - b. Information Management
     - Data bases across curriculum
     - On-line searching
     - Graphing data
   - c. Word processing
     - Across the curriculum
     - Writing with a word processor
     - Keyboarding
   - d. Scientific instrumentation